

SECTION 02722

SANITARY SEWERS (GRAVITY)

PART 1 – GENERAL

1.1 SCOPE OF WORK

The work covered by this Section relates to gravity sanitary sewers and appurtenances including pipe material permitted, installation, testing, and cleanup.

1.2 PIPE MATERIAL PERMITTED

Pipe material for sanitary sewer lines thirty (30") inches and smaller shall be PVC unless otherwise shown on the Plans.

Ductile iron pipe shall be used only when so indicated on the Plans.

1.3 STORAGE OF MATERIALS

The Contractor shall be responsible for safely storing materials for the work until they have been incorporated into the completed project. Keep the interiors of all pipes, fittings, and other accessories free from dirt and foreign matter at all times.

1.4 DEFECTIVE MATERIALS

It shall be the Contractor's responsibility to insure that all necessary materials are furnished and that those found to be defective in manufacture are replaced at no extra cost to the Owner. Materials damaged in handling after being delivered by the manufacturer shall be replaced at the Contractor's own expense. If installed material is found to be defective before the final acceptance of the work, the cost of both the material and labor needed to replace it shall not be passed on to the Owner.

1.5 RELATED WORK SPECIFIED ELSEWHERE

Refer to following Sections of these Specifications for work related to this Section:

- A. Section 02221S – Trenching, Bedding and Backfilling for Sanitary Sewers (Gravity)
- B. Section 02485 – Grassing
- C. Section 02575 – Pavement Repair and Replacement
- D. Section 02600 – Manholes

1.6 STANDARDS

Where materials and methods are indicated in the following specifications as being in conformance with a standard specification, it shall refer in all cases to the latest edition of

the standard specification and shall include all interim revisions. Listing of a standard specification without further reference indicates that the particular material or method shall conform with such listed specification.

All materials to be incorporated in this project shall be first quality, new, and undamaged material conforming to all applicable portions of these specifications. Where deviation from the specifications is necessary because of changes in manufacturing procedures, inability to obtain the specified product, or other extenuating circumstances, a request for the proposed substitution shall be submitted to the Engineer in writing for consideration. Materials failing to conform to these specifications shall not be delivered to the job site unless the Contractor has written approval from the Engineer covering the substitute materials.

PART 2 – PRODUCTS

2.1 GENERAL PIPE REQUIREMENTS

A. QUALITY AND INSPECTION

Latitudes in workmanship and finish allowed by ASTM Specifications notwithstanding, all pipe shall be first quality, of smooth exterior and interior surfaces, free from cracks, blisters, and other imperfections, and true to theoretical shapes and forms throughout each length. All pipe, independent of laboratory tests, shall be subject to the inspection of the Engineer at the pipe plant, trench, or other point of delivery for the purpose of culling and rejecting pipe which does not conform to the requirements of these Specifications. Pipe which does not conform shall be marked as such by the Engineer and shall not be delivered or used in the work. Repairing of rejected pipe will not be permitted.

B. EXPERIENCE OF MANUFACTURER

The manufacturer of the pipe shall submit evidence, if requested by the Engineer, of having consistently produced both pipe and joints of specified quality and satisfactory performance results in service over a period of at least two years. The manufacturing process shall be subject to the approval of the Engineer.

2.2 POLYVINYL CHLORIDE (PVC) PIPE

A. MATERIAL

PVC sewer pipe shall be SDR 35 or heavier sewer pipe as specified in the “Standard Specification for Type PSM PVC Pipe and Fittings”, ASTM Designation D3034, latest revision (for sizes 4”-15” diameter) and as specified in the “Standard Specification for PVC Large Diameter Plastic Gravity Sewer Pipe and Fittings”, ASTM Designation F679, latest revision (for sizes 18”-27” diameter). The pipe shall be highly resistant to hydrogen sulfide, sulfuric acid,

gasoline, oil, detergents, and other chemicals found in sewage and industrial wastes.

B. JOINTS

Joints shall be push-on compression type joints utilizing elastomeric gaskets manufactured in conformance with ASTM F477, latest revision. Design of joint shall be such as to allow deflection of up to three (3°) degrees without affecting the hydraulic seal of the joint, and shall also be such that the joint will not open up even with the gaskets on the opposite side compressed to the maximum.

C. TESTING

All testing of PVC sewer pipe fittings and joints shall be performed in accordance with ASTM F477, ASTM D3034 and ASTM F679 latest revisions.

D. MARKING

All pipe and fittings delivered to the job site shall be marked in accordance with ASTM D3034 or ASTM F679 latest revision.

E. CERTIFICATIONS

Manufacturer shall furnish certifications as follows:

1. That the materials used in the manufacture of the pipe and the elastomeric gaskets conform to ASTM D3034, ASTM F477 and ASTM F679 latest revisions.
2. That the pipe and elastomeric gaskets were manufactured and tested in conformance with ASTM D3034 and ASTM F477 and ASTM F679 latest revisions.
3. Date of manufacture of pipe.

In addition to the certification to be furnished by the manufacturer, the Owner may retain an independent testing laboratory to sample, test, and inspect one (1%) percent of the production of each size pipe furnished for this project. The Owner will bear the expense for the test specimens, which shall be randomly selected by the testing laboratory, or other designated representative of the Owner, from the pipe on the manufacturer's yard which has been inspected and designated for shipment to the project.

F. LENGTHS

Pipe shall be furnished in lengths not less than ten (10') feet or more than thirteen (13') feet.

G. MANUFACTURERS

Pipe shall be manufactured by Certainteed, Can-Tex, Johns-Manville, H and W Industries, CAPCO, Vulcan, NAPCO, or approved equal.

2.3 DUCTILE IRON PIPE

A. MATERIAL

Ductile iron sewer pipe shall conform to ANSI/AWWA Specification C151/A21.51, latest revisions, for ductile iron pipe centrifugally cast in metal or sand lined molds. Pipe shall have bituminous coating on the exterior. Pipe shall have an interior lining of coal tar epoxy, calcium aluminate mortar, amine cured novalac epoxy containing ceramic quartz pigment, or polyethylene lining. Pipe shall be made with 60-42-10 grade ductile iron, or stronger, and pressure Class 350 shall be used unless noted otherwise on the Plans.

B. JOINTS

Joints shall be push-on type compression joints unless otherwise indicated and shall conform to ANSI/AWWA/C111/A21.11, latest revisions. Gaskets and lubricant shall be furnished with the pipe.

C. TESTING

Testing of ductile iron pipe and joints shall be performed in accordance with ANSI/AWWA/C151/A21.51 and ANSI/AWWA/C111/A21.11, latest revisions.

D. MARKING

The weight, pressure, class, manufacturer's mark, year of manufacture and letters "DI" or "DUCTILE" shall be cast or stamped on pipe.

E. CERTIFICATIONS

Manufacturer shall furnish certifications as follows:

1. That the pipe and joints have been manufactured in accordance with ANSI/AWWA/C151/A21.51 and ANSI/AWWA/C111/A21.11, latest revisions.
2. The pipe and joints have been tested in accordance with the procedures and outlined in ANSI/AWWA/C151/A21.51 and ANSI/AWWA/C111/A21.11, latest revisions.

- F. Pipe shall be furnished in lengths of eighteen (18') feet or sixteen (16') feet except for special construction conditions.

G. INTERIOR COATING FOR DUCTILE IRON PIPE

The pipe manufacturer shall submit complete information on the proposed coating system, method of application and application personnel to the Engineer and shall receive the Engineer's approval before undertaking any pipe coating. Certified copies of the manufacturer's testing results shall also be submitted to the Engineer by the pipe manufacturer.

In addition to the certifications to be provided by the pipe manufacturer, the Owner may retain an independent testing laboratory to inspect and label the pipe before the coating application begins. If so directed, the independent testing laboratory provided by the Owner will make random selections of up to one (1%) percent of the coated pipe sections which will be visually inspected, checked for holidays, and tested for dry film thickness. Any patching or re-coating of the test sections shall be done by the Applicator at no additional cost. Any changes in procedure or any re-coating necessary to correct defective coating systems shall be carried out promptly upon notification of such deficiencies.

1. Interior coating for ductile iron pipe shall consist of a coal tar epoxy lining system applied in strict accordance with the coating manufacturer's recommendations and these Specifications. The coating shall be equivalent to Kopcoat 300-M or Tnemec 46H-413 Hi Build Tname – Tar.
2. Cured novalac epoxy lining for ductile iron pipe shall be an amine cured novalac epoxy containing at least 20% by volume of ceramic quartz pigment. Lining shall be forty (40) mils nominal thickness.
3. Polyethylene lining for ductile iron pipe shall be of virgin polyethylene complying with ASTM D-1248 compounded with sufficient lamp black to resist ultraviolet rays during above ground storage of the pipe. Lining shall be heat fused to the interior of the pipe and shall be approximately forty (40) mils thick.

2.4 FITTINGS AND SERVICE LINES

Fittings, service lines, and jointing material, unless otherwise directed by the Engineer, shall be in conformance with the requirements of the specifications for that portion of the main sewer where installed. Mechanical type fittings may be used on short sections of ductile iron gravity sewers if approved by the Engineers. Ductile iron fittings shall have interior lining and exterior coating as specified for pipe with which they are used. Fittings shall be field assembled in conformance with the manufacturer's directions. Ductile iron compact fittings shall conform to ANSI A21.53.

Ductile iron gravity sewers shall not be connected to PVC gravity sewers except by means of a manhole or by other methods approved by the Engineer.

2.5 CASING PIPE

The minimum material requirements for casing pipe used in highway and railroad crossings shall be steel conforming to ASTM A139, Grade B. Minimum yield strength shall be 35,000 psi. **All casing pipe used must meet the approval of the permitting authority.** Nominal casing diameter shall be as indicated on the Plans. Joints shall be continuously welded. Casing pipe and joints shall be leakproof and capable of withstanding Cooper E-80 loading. Casing pipe shall be coated as specified herein.

The minimum wall thickness of casing pipe shall be as shown in the table below:

<u>Nominal Diameter (Inches)</u>	<u>Minimum Wall Thickness (Inches)</u>	
	<u>With Coating</u>	<u>Without Coating</u>
Under 14	0.188	0.251
14 and 16	0.219	0.282
18	0.250	0.313
20	0.281	0.344
22	0.312	0.375
24	0.344	0.407
26	0.375	0.438
28 and 30	0.406	0.469
32	0.438	0.501
34 and 36	0.469	0.532
38, 40, 42	0.500	0.563

Where specified, coating for steel casing pipe shall be a two component, self-priming, chemically cured coal tar epoxy-polyamide protective coating. Minimum dry film thickness of completed coating shall be sixteen (16) mils. Material shall be Kopcoat 300 M, Tnemec 46H-413 Hi Build Tneme – Tar or equal. Preparation shall be SP6 commercial blast.

2.6 CONCRETE

A. CLASS “A” CONCRETE

Class “A” concrete shall have a minimum compressive strength of four-thousand (4,000) pounds per square inch in twenty-eight (28) days and shall contain not less than six-hundred (600) pounds of cement per cubic yard.

B. CLASS “B” CONCRETE

Class “B” concrete shall have a minimum compressive strength of three-thousand (3,000) pounds per square inch in twenty-eight (28) days and shall contain not less than five-hundred-fifty (550) pounds of cement per cubic yard.

2.7 CHECK DAMS

Consists of Class “B” Concrete as listed in 2.6.B.

A. REQUIRED DIMENSIONS

1. 1 foot thick along pipeline.
2. Key 2 feet into trench wall (each side) except in rock where dam shall be against rock/trench wall.
3. Depth – From bottom of trench to 12” above gravel envelope.

PART 3 – EXECUTION

3.1 GENERAL

The Contractor will be held completely responsible for any damage to pavement, sidewalks, curbs, gutters, meter or valve boxes, street inlets, poles and guywires, or other structures or appurtenances as a result of construction operations. It should be specifically noted that the Contractor shall be responsible for damage even though the character or nature of the original pavement or structure was such that it was not capable of carrying the load of the construction equipment regardless of the construction methods used.

The Contractor shall take precautions as may be necessary to avoid endangering personnel, pavement, adjacent utilities, or structures through cave-ins, slides, settlement, or other soil disturbances resulting from construction operations. The Contractor shall furnish and maintain barricades, signs, flashing lights, and other warning devices as necessary for public safety and as required by the Manual on Uniform Traffic Control Devices, Part 6.

The Contractor shall plan construction operations so as to cause a minimum of inconvenience to property owners and to traffic. Flaggers shall be provided as required on heavily traveled streets to avoid traffic jams or accidents. No road, street, or alley may be closed unless absolutely necessary, and then only if the following conditions are met:

- A. Permit is secured from appropriate State, County, or Municipal authorities having jurisdiction.
- B. Fire and Police Departments and other emergency services are notified before road is closed.
- C. Suitable detours are provided and are clearly marked.

No driveways shall be cut or blocked without giving twenty-four (24) hour notice to the occupant of the property. Every effort shall be made to schedule the blocking of drives to suit the occupant's convenience, and except in case of emergency, drives shall not be blocked without an alternative access being provided.

Whenever pipe laying operations are to be discontinued for an extended period of time, the end of the pipe shall be carefully secured to avoid displacement or misalignment, and a tight fitting plug or stopper shall be placed in the line. Upon resumption of laying operations, the plug or stopper shall not be removed from the line until any water, mud, or other debris has been removed to avoid entry into the completed section of the sewer.

Installation of sewer pipe shall conform to provisions of these specifications and recommendations of the pipe manufacturer. Installation instructions provided by the pipe manufacturer shall be available at all times at the location of the work.

The proper gaskets and lubricants shall be furnished by the pipe manufacturer, and lubricants shall be delivered to the job site in properly labeled, unopened containers.

Wye branches and other fittings shall be placed in the sewer line as shown on the Plans or as directed by the Engineer as pipe laying progresses. The Contractor shall keep accurate records of their location.

When sewer lines are to be constructed near water mains, horizontal and vertical separation shall be maintained as described below:

Horizontal Separation: Whenever possible, sewers should be separated horizontally from water mains a minimum of ten (10') feet. If this is not possible, the lines may be laid closer provided they are in separate trenches, and if the elevation of the top of the sewer is at least eighteen (18") inches below the bottom of the water main.

Vertical Separation: When a sewer line must cross a water main, the top of the sewer should be at least eighteen (18") inches below the bottom of the water main.

If the elevation of the sewer cannot be varied to meet the above requirements, relocate the water main to provide this separation, or else reconstruct it with mechanical joint ductile iron pipe for a distance of ten (10') feet on each side of the sewer with a full joint of the water main centered on the sewer. If it is impossible to obtain proper horizontal and vertical separation as stipulated herein, construct both the water main and the sewer of mechanical joint ductile iron pipe and pressure test each.

The Contractor shall submit a proposed construction schedule for the Engineer's approval before construction begins. If the sewer is to be installed in a proposed road, the road shall be graded to subgrade before the sewer is installed. The normal requirement will be to begin pipelaying at the lower end of any proposed line and continue laying upstream until the line is completed. Construction will begin at points where proposed sewers tie

into existing sewers, existing or proposed pump stations, or existing or proposed treatment facilities.

3.2 PIPE INSTALLATION

All grade and alignment stakes shall be set and cut sheets prepared for installation of gravity sewers in accordance with the following procedures for the two (2) types of projects for which these specifications apply:

A. PROJECTS BEING CONSTRUCTED WITH PUBLIC FUNDING UNDER CONTRACT TO THE DEPARTMENT

1. General

The Contractor shall be responsible for setting all grade stakes, lines and levels and preparation of cut sheets. The Contractor shall provide level, level rod and tripod on the job site at all times for the purpose of checking grades, as deemed necessary by the Engineer. All grade and alignment stakes for construction under this project shall be set by a land surveyor registered to practice in the State, and all costs thereof shall be borne by the Contractor. The requirement for this work to be accomplished by a registered land surveyor may be waived by the Engineer in the event the Contractor desires to utilize his own personnel who are qualified to set the grade and alignment stakes. The Contractor shall assume all responsibility for the correctness of the grade and alignment stakes.

The Contractor may use batter boards or a properly calibrated beam device. No claim for extra work will be allowed for alleged inaccuracy of the laser beam device. Grade hubs for laser beams shall not exceed 100 feet apart with centerline hubs every 50 feet to check laser and grade between manholes.

If the Contractor elects to use batter boards, he shall provide and maintain on the work at all times a gauge rod of sufficient length to reach from the invert of the sewer pipe being laid to the top line strung on the three batter boards. The gauge rod shall be graduated and numbered each foot of its entire length. The gauge rod shall be equipped with either a plumb line or two spirit levels and the utmost care used to insure a truly vertical gauge rod at the time a reading is taken and pipe is being set.

One week prior to the commencement of trench excavation, the Contractor shall prepare and submit to the Engineer for review four (4) copies of detailed Cut Sheets showing the beginning and ending manholes; the distance between manholes; the grade, size and type of line; the depth of cut; etc. The form of Cut Sheet shall be provided to the Contractor. All expense for the preparation of Cut Sheets shall be

borne by the Contractor and be included in the unit price bid per foot of pipe.

Cut Sheets must be reviewed by the Engineer in writing before trenching operations may be permitted. It shall be the responsibility of the Contractor to prepare Cut Sheets (one week) in advance of his anticipated trenching schedule.

B. PROJECTS BEING CONSTRUCTED WITH PRIVATE FUNDING UNDER THE DEVELOPMENTAL PROCEDURES OF THE DEPARTMENT

The sewer shall be staked and the cut sheets prepared by the Developer's Engineer. Three (3) copies of the cut sheets shall be given to the Department for review and approval; the Department will provide the Developer's Contractor with the cut sheets.

The trench for the sewer pipe, including the bottom, bedding, sides, backfilling, and any necessary foundation stabilization, dewatering, sheeting or shoring, and the disposal of materials shall be prepared or done in accordance with Section 02221S, Trenching, Bedding, and Backfilling for Sanitary Sewers (Gravity).

The Contractor shall exercise care in the storage and handling of pipe, both on the storage yard and at the site of laying operations. Suitable clamps, slings, or other lifting devices shall be provided for handling pipe and fittings. Pipe and fittings shall be carefully lowered into the trench piece by piece. AT NO TIME SHALL A SECTION OF PIPE BE ROLLED OR DROPPED FROM A TRUCK OR INTO THE TRENCH. Pipe and fittings shall be inspected for defects and for dirt or other foreign material immediately before placing them in the trench. Suitable swabs shall be available at the site for laying operations, and any dirt or foreign material shall be removed from the pipe before it is lowered into the trench.

Alignment and grade shall be carefully maintained during the laying operations. The method used for maintaining grade and alignment must be acceptable to the Engineer and to the Owner. If the Contractor elects to use batter boards, they shall provide and maintain on the work at all times a gauge rod of sufficient length to reach from the invert of the sewer pipe being laid to the top line strung on the three batter boards. The gauge rod shall be graduated and numbered each foot of its entire length. The gauge rod shall be equipped with either a plumb line or two spirit levels and the utmost care used to insure a truly vertical gauge rod at the time a reading is taken and pipe is being set. If the Contractor elects to use laser beams, they must set reference points for both line and grade at each manhole. Where grades are 0.6% or less, check the elevation of the beam each one hundred (100') feet with an offset point or engineer's level. Laser beams shall be used in accordance with manufacturer's instructions.

Each pipe shall be laid on an even, firm bed, so that no uneven strain will come to any part of the pipe. Particular care shall be exercised to prevent the pipes bearing on the sockets. Bell holes for bell and spigot pipe shall be dug at each point as hereinbefore specified. The bell-end of the pipe shall be laid upgrade.

Each pipe shall be laid in the presence of an Inspector where possible. If an Inspector cannot be present while the pipe is being laid, the Contractor may go ahead and lay the pipe but not backfill the trench until the Inspector has inspected the pipe. If the Contractor has laid and "safed up" two hundred (200') feet of pipe without the Inspector being present, the Contractor must lay no more pipe until the Inspector has inspected the pipe that has already been laid and given permission to backfill the pipe and to proceed with laying pipe. The laying of the pipe with an Inspector being or not being present does not relieve the Contractor of the responsibility to install the pipe in accordance with the Specifications.

INSTALLATION SPECIFICATIONS:

A. PVC PIPE

Installation of the pipe shall be in strict accordance with ASTM Designation D-2321, Standard Recommended Practice for Underground Installation of Flexible Thermoplastic Sewer Pipe. Due precautions must be taken in placing the bedding under the pipe haunches and on the sides of the pipe to insure proper support of the pipe and at the same time avoid any misalignment. Attention is called to the provisions by these specifications which limit pipe diametric deflection to five (5%) percent.

After the pipe has been placed and brought to grade, the pipe shall be held in place while crushed stone is carefully worked in around the pipe for firm support of bottom and sides. Extreme care shall be taken in backfilling around the pipe to avoid raising the pipe above the grade line but at the same time provide the required support. The crushed stone shall be placed in small quantities and distributed by hand up to a point twelve (12") inches above the top of the pipe.

B. DUCTILE IRON PIPE

Unless otherwise indicated, ductile iron pipe shall be laid with slip type compression joints, equal to the manufacturer's standard for pressure water pipe, and assembly of the joints shall be in accordance with the manufacturer's recommendations using lubricant and accessories as provided by the pipe manufacturer.

Whenever it is necessary to cut a joint of pipe in order to fit the trench conditions, the cutting shall be done using the equipment as recommended by the manufacturer for the specific type of pipe involved. The cut shall be made so as to leave a smooth end at right angles to the axis of the bore, and the end shall be bevelled or finished as required to make the joint without risk of damage to gasket.

3.3 CHECK DAM INSTALLATION

Check dams shall be installed in the trench of new, replaced, or rehabilitated gravity sewer lines. The location of these check dams shall be as given below:

1. 15 feet upstream of each manhole where manholes are spaced between 250 and 400 feet apart.
2. 10 feet upstream of every other manhole where manholes are spaced 250 feet apart or less.
3. Where the gravity sewer line crosses a stream/creek, dams shall be installed on each side.

3.4 CLEANING, TESTING, AND ACCEPTANCE

A. GENERAL

Before acceptance of any sewer or system of sewers, lines shall be cleaned and tested to the satisfaction of the Engineer. Where any obstruction is met, the Contractor will be required to clean the sewers by means of rods, swabs, or other instruments. Lines and manholes shall be flushed and washed down before final inspection, at the request of the Engineer. Pipelines shall be straight and show a uniform grade between manholes, and the Contractor will be required to correct any variations therefrom which may be discovered during the inspection. No final inspection will be scheduled by the Engineer until the Contractor has conducted an inspection and believes the project to be ready for such final inspection. Should the Engineer begin a final inspection at the request of the Contractor and find that the sewers have not been cleaned or defects have not been corrected, the inspection will be terminated and will not be rescheduled until the Contractor again advises that the project is ready for inspection.

Acceptance of the project shall involve both a visual inspection and a leakage test. The procedures shall be as outlined hereinafter. The work will not be accepted until both the visual inspection and leakage test results are satisfactory.

B. VISUAL INSPECTION

The Engineer will, as a part of the final inspection, make the necessary visual inspections to verify the quality of workmanship. Such inspections shall include examination of manholes, "lamping" or "flashing" sewer lines, and observation of cleanup, pavement replacement, etc.

Any defects such as sags, humps, bends, or other evidence of misalignment of sewers, visible leaks, obstructions, cracked or broken pipe, or failure to restore the surface to a satisfactory condition must be corrected to the Engineer's satisfaction before acceptance.

Sewers constructed of flexible PVC pipe will be checked for roundness. The Contractor shall provide a suitable rigid ball or 9-arm mandrel having a diameter equal to ninety-five (95%) percent of the inside pipe diameter which shall be pulled through the sewer. Any section of the sewer showing a deflection of more than five (5%) percent shall be relaid to correct the condition.

C. LEAKAGE TESTS

The Contractor shall provide suitable equipment for making air pressure tests and for measuring infiltration.

Air pressure tests shall be made between adjacent manholes for the first sections of sewers laid with ductile iron or PVC sewer pipe as soon as the pipe sections are completed in order to check the tightness of the line and to discover any changes in construction procedure that may be needed to secure the desired watertightness. Thereafter, air tests will be run on such sections of the lines as the Engineer may designate.

Procedure for air testing shall be as specified in UNI-BELL UNI-B-6 and as follows:

1. After sewer has been cleaned, test plugs shall be inserted at end of test section. Plugs shall be suitably braced or blocked.
2. Air should be slowly added to the plugged section until a pressure of 4 psi is reached. At least two minutes should be allowed for temperature stabilization.
3. With the air pressure at 4 psi disconnect the air supply.
4. When air pressure drops to 3.5 psi begin timing with a stopwatch and determine time required for pressure to drop to 2.5 psi.
5. Required test times for various pipe diameters are shown in the following table.
6. If the pressure drops more than 1.0 psi during the test time, the line is presumed to have failed the test. If a 1.0 psi drop does not occur within the test time, the line has passed the test.

<u>Pipe Diameter</u>	<u>Minimum Test Time (Min;Sec)</u>	<u>Pipe Length for Min. Time (ft)</u>	<u>Test Time for Longer Lgth (Sec)</u>
4"	3:46	597	0.380 L
6"	5:40	398	0.854 L
8"	7:34	298	1.520 L
10"	9:26	239	2.374 L
12"	11:20	199	3.418 L
15"	14:10	159	5.342 L
18"	17:00	133	7.692 L
21"	19:50	114	10.470 L
24"	22:40	99	13.674 L
27"	25:30	88	17.306 L
30"	28:20	80	21.366 L

Where the ground water table is known to be above the sewer, all pressures shall be raised by an amount equal to the ground water pressure (0.4 psi per foot of water). The air pressure test may be made with the pipe in a dry or normal condition, but in the event the section fails to pass the test, the Contractor will be permitted to repeat the test after having soaked the pipe to produce moisture saturation. Caution should be exercised to avoid overpressuring the sewer and to avoid blowing out of test plugs. No one should be permitted to enter an adjacent manhole while a section of sewer is under test.

Where the natural ground water is twenty-four (24'') inches or more above the top of a section of pipe, measure the flow of water in the pipe and the rates of seepage and infiltration. Measure the flow rate by using a calibrated weir. Leave the weir in the line until the flow rate has stabilized. The Contractor is responsible for verifying the ground water level by providing sight gauges in manholes or digging test holes in suitable locations. The infiltration observed in any section of sewer less than thirty (30'') inches in diameter shall not exceed twenty-five (25) gallons per inch of pipe diameter per mile of line per day. No measurable infiltration will be acceptable in ductile iron pipe.

All visible leaks in pipes and manholes must be corrected regardless of amount of infiltration. The repair or replacement of all defective materials shall be done at the Contractor's expense.

The Contractor shall furnish all equipment and personnel for making the above-described tests, but the tests shall be made at a time acceptable to the Engineer and shall be witnessed by the designated representative of the Engineer.

3.5 CONNECTIONS, APPURTENANCES, AND SPECIAL CONDITIONS

A. CONNECTIONS TO EXISTING SYSTEM

No new sewer line shall be connected to the existing sewerage system until all new upstream construction has been completed, is free of foreign materials, and obvious defects have been corrected. New lines, then, must remain disconnected from the existing system by actual physical separation, by plugs of a type approved by the Engineer, or by other means approved by the Engineer.

New sewer connections with old existing sewers shall be made within a manhole. Where an old manhole exists at the point of connection of new and old sewers, it shall be core drilled, a rubber boot installed, be repointed, and any loose bricks or blocks in the walls of the old existing manhole shall be relaid. The Contractor shall reconstruct the invert of the manhole to accommodate the new connection. At locations where new sewers are shown to be connected to existing sewers at a new manhole, the Contractor shall first expose the existing sewer and install a supporting timber beam with suitable straps around the pipe so as to bridge the excavation from the new manhole. The manhole shall then be constructed complete with invert and frame and cover. Under special conditions, and with the approval of the Engineer, the Contractor may temporarily block and/or divert

sewage flows to facilitate construction operations. No bypassing of sewage flows to ditches, streams, storm sewers, or the ground will be permitted. Actual physical connection of the sewers will be made at a later date, as directed by the Engineer.

In all cases the Contractor shall locate and uncover existing sewers and shall verify invert elevations before laying the connecting sewer so as to allow opportunity for making adjustments to compensate for discrepancies.

When connections are made with sewers carrying sewage or water, special care must be taken that no part of the work is built under water; a flume or dam must be installed and pumping maintained if necessary to keep the new work in the dry until completed and concrete or mortar has set up.

B. SERVICE CONNECTIONS

Sewer service lines shall be provided as shown on the plans, cut sheets, or as directed by the Engineer. Service connections shall consist of six (6") inch wyes and bends, risers, double wyes and bends, as required and six (6") inch house service lines. Pipe and fitting joints shall be compression type as used on the main sewer. Service pipe and fittings shall be of the same material as used for the main sewer.

As far as possible, the branch of the wye shall incline upwards at approximately forty-five (45°) degrees above a horizontal line normal to the flow of the sewer. A forty-five (45°) degree bend, short radius, shall be used to connect the service wye to the house service. The branch of the wye, including the bend, shall be placed on a solidly compacted bed of crushed stone and connected to the wye in such a manner as to be self-supporting and to relieve the strain on the branch and the bend. Where trench depths are such that risers are required, the branch of the wye and the bend shall be set in a vertical position and the entire length of the wye encased in concrete in conformance with the Standard Detail Drawing. Risers shall extend to the heights directed by the Engineer and shall be encased in a brick masonry stack as shown on the Standard Detail Drawing. Bends and/or double wyes and bends shall be used to connect the riser to the house sewer.

Service pipe shall be laid on a slope of one-fourth (1/4") inch per foot or, where this grade is not available and the Engineer specifically approves, one-eighth (1/8") inch per foot may be used. In no event shall the service line be less than three and one-half (3½') feet deep to invert of the pipe at the property line. Sewer service lines shall conform to details as shown on the Standard Detail Drawing and shall terminate **in the center of the lot** at the property line with a watertight PVC cap or plug. After the cap or plug is placed in its proper position, it shall be backfilled with crushed stone to a point twelve (12") inches above the cap or plug.

Markers shall be installed at the end of all house service lines. The materials for the marker shall be either (a) a two (2") inch creosoted wood stake or (b) a one inch by two (1" x 2") inch untreated wood stake to which is fixed non-ferrous or

galvanized wire of a diameter not less than sixteen (16) gauge extending the full length of the stake. The stake shall be placed vertically in the trench and shall extend from the invert of the sewer to a point six (6") inches above the surface of the ground, except in streets and roadways where the stakes shall be cut off to a point six (6") inches below the traveled surface.

C. CONCRETE PIERS

Concrete piers for sanitary sewers shall be constructed of Class "A" concrete and shall conform to the details shown on the Plans. A saddle conforming to the outside of the pipe shall be constructed in the top of all piers. Pipe shall be blocked to proper grade and then grouted in place in the saddle with 1:2 cement mortar. Pipe straps shall be installed on all piers.

Piers supporting pipelines across streams shall be anchored into rock in accordance with details shown on the Plans, so as to resist overturning during periods of flood stages in the stream. Holes shall be drilled two and one-half (2½") inches minimum diameter into the rock after excavation for the footing is complete, and reinforcing bars embedded in grout made with high-early strength cement poured into the holes. With wet holes, grout shall be deposited by means of a trowel. Straight bars shall be used and bent over for anchorage after the concrete has attained its full strength.

D. STATE HIGHWAY AND RAILROAD CROSSINGS

The installation of sewer lines along and across state highways shall be made in accordance with the details shown on the Plans, as specified herein, and with all requirements of the Tennessee Department of Transportation (TDOT) with reference to construction operations, safety, traffic control, road maintenance and repair, etc.

The installation of sewer lines along and across railroads shall be made in accordance with the details shown on the Plans, as specified herein, and with all requirements of the Railroad Company with reference to construction operations, safety, maintenance of service, etc.

Permits for such work will be obtained by the Owner. All costs for labor, materials, and supervisory personnel furnished by TDOT and the Railroad Company in connection with the work, if any, shall be at the expense of the Contractor. The Contractor shall fully inform himself/herself of the conditions and insurance requirements of the permit and fully comply with those conditions and requirements.

The Contractor shall be responsible for fully informing himself with regard to all TDOT and Railroad Company regulations and conditions relating to pipeline crossings.

The Contractor shall be responsible for notifying TDOT and the Railroad Company when work is to begin on the crossing.

3.6 CLEANUP

The Contractor shall not, without the permission of the Engineer, Owner, and property owner, remove from the line of work any earth excavated therefrom. Earth which may be suitable for backfilling or surfacing shall be used for that purpose.

As soon as the backfilling of any excavation is completed, and when in areas of existing development, the Contractor must at once begin the removal of all surplus dirt except that actually necessary to provide for the settlement of the fill. The Contractor shall also remove all the pipe and other material placed or left on the street except material needed for the replacement of paving, and the street shall be opened up and made passable for traffic. Following the above work, the repairing and complete restoration of the street surfaces, bridges, crossings, and all places affected by the work shall be done as promptly as possible.

All excavated material shall be cleared from adjacent street surfaces, gutters, sidewalks, parkways, railroads, grass plots, yards, etc., and the whole work shall be left in tidy and acceptable condition.

The Engineer shall be sole authority in determining time in which rough and final cleanup shall be prosecuted. Rough cleanup shall consist of removal of rocks larger than one (1') foot in any dimension, grading of excess backfill material over pipeline or removal of said material, opening of any drainage device, restoration of any street or roadway to condition so that traffic may safely and conveniently use street or road, restoration of pedestrian ways to condition where pedestrians may safely and conveniently use same. Rough cleanup shall, in general, be prosecuted no later than one (1) day after pipe laying and backfilling or no farther behind pipe laying operations than one thousand (1,000') feet; whichever time limit is shortest shall govern. Final cleanup consisting of pavement replacement, sidewalk replacement, removal of rocks, hand raking, seeding, strawing, etc., of lawns and neutral grounds, adjusting grade of ground over pipeline, property repairs, and other items necessary to restore the property to a condition similar or equal to that existing prior to construction shall, in general, be prosecuted no later than three (3) weeks after completion of backfilling.

Regrassing and pavement replacement shall be done in accordance with the applicable Sections of these specifications.

3.7 ACCEPTANCE OF WORK

Sewer lines and appurtenances will not be considered ready for acceptance until all provisions of these Specifications have been complied with, until all tests have been satisfactorily completed, and until final inspection of the work has been made. Sewage flows shall not be diverted into new sewers until after such time as final inspection of the lines has been made by the Engineer and permission granted thereof.

END OF SECTION 02722